Direct Seeding into Heavy Irrigated Stubble Instead of Burning

TECHNICAL PROPOSAL

A. Project Approach/Methodology

Many deep-well irrigators in east-central Washington practice a continuous winter wheat rotation (i.e., grow winter wheat on the same field every year). Irrigated wheat grain yields range from 90-to 140-bushels per acre with residue production of 10,000 pounds or more per acre. After grain harvest in August, the traditional practice is to burn the stubble and invert the surface soil with moldboard plow tillage in preparation for sowing in September. Generally, growers feel they need to burn their fields because high residue levels hamper seeding operations. Alternatives to field burning are needed to reduce smoke emissions and maintain air quality.

Another reason why irrigated growers burn and moldboard plow winter wheat stubble is to control downy brome, a winter annual grass weed. Previous research has shown that long-term control of downy brome is very difficult in continuous irrigated winter wheat using no-till. Therefore, new crop rotation and stubble management strategies are needed to make no-till (without burning) work. Smoke emissions from burned cereal stubble in irrigated (and high rainfall area) fields is a major source of air pollution. New farming methods are needed that eliminate the need to burn. Research is needed to develop non-burn farming methods for high-residue situations which are agronomically and economically feasible.

The objective of this long-term (6-year) project is to determine the feasibility of direct seeding into high levels of residue as a substitute for burning in irrigated cropping systems. Specific objectives are to:

1. Test a 3-year crop rotation of winter wheat - spring barley - winter canola. Crops will be sown with a Cross-slot direct-seed drill into (i) standing stubble, (ii) after mechanical removal of stubble, and (iii) after burning the stubble. An additional treatment of annual winter wheat sown after stubble burning + moldboard plowing (sown with a double-disc drill) will be included as a check (see Appendix 1).

2. Evaluate and develop effective techniques for sowing crops into heavy surface stubble using direct seeding methods.

3. Document cumulative effects of a diverse direct-seed crop rotation under three stubble management practices on soil physical and biological properties, water use efficiency, diseases, weed ecology, and farm economics. Compare these effects to those under the check treatment (i.e., continuous winter wheat after stubble burning + moldboard plowing).

Grower advisors for the project report that grain yields in the 3-year rotation must average 100 bu/a winter wheat, 3 ton/a spring barley, and 3,000 lb/a winter canola to be competitive with their traditional annual winter wheat after burning and moldboard plowing. Our goal, therefore, is to meet or exceed the above mentioned grain yields through direct seeding into standing stubble.

B. Work Plan

This study was initiated in August 1999 on 10 acres of prime cropland at the Washington State University Dryland Research Station at Lind. Start-up funds for the project were provided by the U.S. Environmental Protection Agency. To obtain baseline residue levels to begin the experiment, the entire 10 acres was planted uniformly to Madsen winter wheat in September 1999. Grain yield (harvest August 2000) was 110 bu/a and straw production exceeded 10,000 lb/a.

Beginning in the 2001 crop year, a 3-year crop rotation of winter wheat - spring barley - winter canola is grown under three stubble management methods. These are sowing crops: *i*) directly into standing stubble, *ii*) after mechanical removal of stubble (i.e., after swathing and bailing), and *iii*) after burning of stubble. A check treatment of continuous annual winter wheat sown after stubble burning + moldboard plowing is also included. The experimental design is a split-split plot with four replications. Each portion of the 3-year direct-seed crop rotation in each stubble management method is sown each year. Thus there are 40 plots (3 crops x 3 stubble management practices + the check continuous winter wheat x 4 replications). Appendix 1 shows the design and plot layout of the project for the current 2002 crop year.

All direct-seeded plots are sown with a low-disturbance "Cross-slot" drill which delivers seed and liquid fertilizer in one pass through the field. The burn + moldboard plow continuous winter wheat check plots receive granular fertilizer before moldboard plowing and are sown with a double disc drill with 6-inch row spacing.

Planting spring barley into heavy winter wheat stubble has so far not been a problem because over-winter decomposition made the straw fairly friable. There were no differences in wheat, barley, or canola grain yields among residue management treatments in the 2001 crop year (data not shown). Spring barley was pleasant surprise because it was easy to establish, there were no weeds, and grain yields were excellent. A total of 15 inches of irrigation water (6" fall, 9" spring) plus 8.3 inches of precipitation was used in the 2001 crop year.

For the 2002 crop year and onward, we direct seed winter canola into barley stubble just after barley harvest into dry soil and then add 6 inches of irrigation water. The subsequent barley volunteer plants are controlled using Assure II™ grass herbicide. We achieved excellent stands of winter canola using this method in the 2002 crop year.

In the 3-year rotation, irrigation water is applied in late August into standing stubble, after burning of stubble, and after mechanical removal of stubble (see calendar of operations). The burn + moldboard plow annual winter wheat check plots are prepared by first burning all above-ground residue, irrigating, fertilizing with granular fertilizer, and completely inverting the top 5 inches of soil by moldboard plow, packing the soil surface, and sowing with a double-disc drill.

Measurements

Comparisons among stubble management systems within the 3-year rotation as well as with the traditionally-grown annual winter wheat are made. Soil water is measured to a depth of six feet in all 40 plots just after harvest and again in mid-April (before spring irrigation water is applied) using neutron attenuation and gravimetric methods. Weed species composition, number, and dry biomass in each plot are measured just before harvest within a 6 ft X 6 ft sampling square.

Diseases in all crops are measured several times during the growing season by Tim Paulitz, USDA-ARS plant pathologist. As soil biological changes are expected to occur relatively rapidly, complete 0-to 4-inch surface soil cores from all 40 plots are analyzed each year by Ann Kennedy, USDA-ARS soil microbiologist. The soil properties analyzed include bulk density, pH, electrical conductivity, organic matter, aggregate stability, and organic C and N. Soil microbial analysis includes soil biomass, respiration, and enzyme activities using phospholipid fatty acid and fatty acid methyl ester (FAME) analyses. An economic analysis of the 3-year rotation vs. annual winter wheat and among residue management treatments will be conducted by Doug Young, WSU agricultural economist.

Grain yield is measured by first cutting 2-ft-wide alleys to separate the no-till treatments (i.e., standing stubble, stubble mechanically removed, and stubble burned), and harvesting each 165 ft-long treatment using a plot combine and then weighing each sack of grain on a digital scale. These methods allow us to obtain very precise grain yield measurements. A commercial-size combine, equipped with straw chopper and chaff spreader, is used to harvest remaining grain and uniformly spread residue and chaff in each treatment.

C. Project Schedule

This irrigated cropping systems study requires numerous field operations be conducted in a timely manner throughout the year. The study is located at the Lind Research Station were we have the facilities, equipment, and personnel to closely supervise this complex and labor-intensive experiment. A generalized project schedule is shown below.

Generalized schedule of field operations for the irrigated cropping systems experiment at Lind, WA.

July: -Harvest canola.

Aug: -Harvest wheat and barley.
-Mechanically remove stubble by swathing and bailing in 3-year rotation.
-Burn stubble in designated areas in the 3-year rotation as well as in the continuous annual winter wheat plots.
-Direct seed and fertilize winter canola (@8 lb/a) into previous barley crop (i.e., standing stubble, mechanical stubble removal, and stubble burned).
-Irrigated 6 inches all plots.

Sept. -Broadcast dry fertilizer (120 N, 30 P, 30 S) in continuous annual winter wheat plots.
-Moldboard plow and pack continuous winter wheat plots.
-Apply post-harvest herbicide (glyphosate @ 22 oz./a) to direct-seed plots.
-Direct seed winter wheat @100 lb/a and fertilize (120 lb N, 30 lb P, and 30 lb S per acre as liquid Solution 32) into winter canola stubble.
-Seed continuous annual winter wheat plots @100 lb/a with double-disc drill.
-Apply grass herbicide (Assure II @ 8 oz/a) to winter canola plots.

Apr. -Direct seed spring barley @ 100 lb/a and fertilize 170 lb N, 30 lb P, 30 lb S per acre into winter wheat stubble.
-Top dress winter wheat and winter canola with granular N @ 50 lb N per acre.
-Apply 1.5 pints per acre bronate in-crop broadleaf herbicide in winter wheat.
-Irrigate 3 inches all plots.

May -Apply 1.5 pints bronate in-crop broadleaf herbicide in spring barley.
-Irrigate 6 inches all plots.

Jul/Aug:-Harvest winter canola, winter wheat, and spring barley.
-Cycle begins again.

D. Deliverables

This project provides irrigated growers in east-central Washington new information on the feasibility of a diverse 3-year crop rotation with different stubble management practices. Expected outcomes are development of effective new strategies for direct seeding into heavy surface stubble. This will include documentation of changes across cropping systems and stubble management practices on: 1) soil quality parameters such as organic carbon, microbial biomass, aggregate stability, etc.; 2) an economic analysis of cropping practices; 3) the extent of soil-borne disease pressure; 4) soil water dynamics and water use efficiency as affected by residue management and cropping systems; 5) a complete assessment of weed species in each of the systems; and 6) an understanding of the long-term agronomic feasibility of intensive irrigated cropping without burning or tillage.

Oral presentations for this study are made at the annual WSU Lind Field Day (average attendance is 160), grower meetings, and at scientific conferences. Written results will be extended in popular grower publications, university extension bulletins, and in refereed scientific journals. This study has already received regional and national media attention and is viewed by many as a keystone research project for direct seeding in the Pacific Northwest.

MANAGEMENT PROPOSAL

A. Project Management

1. Project Team

<u>Scientists and Technicians</u>

William Schillinger (PI), WSU research agronomist, Lind
Harry Schafer, WSU research technician, Lind
Bruce Sauer, WSU farm manager, Lind
Ann Kennedy, USDA-ARS soil microbiologist, Pullman
Doug Young, WSU agricultural economist, Pullman
Tim Paulitz, USDA-ARS plant pathologist, Pullman
Steve Schofstoll, WSU technical assistant, Lind

Advisors
Neil Fink, grower, Odessa
Clark Kagele, grower, Odessa
Keith Schafer, grower, Odessa
Jeff Schibel, grower, Odessa
Gary Schell, grower Odessa
John Aeschliman, grower, Colfax
Perry Dozier, grower, Waitsburg

2. Qualifications/Experience

The Principal Investigator (PI) for the project is William Schillinger. The PI is widely published and has extensive experience directing long-term cropping systems research projects (see attached vita). Schillinger directly supervises Harry Schafer, Bruce Sauer, and Steve Schofstoll. Schafer, Sauer, and Schofstoll are experienced and well-qualified in equipment mechanics and repair, equipment operation, farming techniques, field measurement methods, and statistical analysis. Ann Kennedy, Tim Paulitz, and Doug Young (not funded in this proposal) are widely recognized as experts in their respective fields.

Neil Fink, Clark Kagele, Keith Schafer, Jeff Schibel, and Gary Schell are deep-well irrigators in east-central Washington. John Aeschliman and Perry Dozier farm in the high-precipitation region of eastern Washington where this type of research is directly applicable. They actively encouraged this research and were instrumental in designing the project. These growers will serve as advisors throughout the life of the project. Scientists and grower advisors meet at least once (usually twice) each year to view and discuss the experiment.

B. Experience of the Applicant

Please refer to the attached vita of the Principal Investigator.

C. References

The applicant grants permission to contact the following references:

Mr. Jeff Schibel
Deep-well irrigator and advisor
569 Kagele Road N
Odessa, WA 99159
Tel:509-982-0136
E-mail:Sfi@Odessaoffice.com

Dr. Robert Papendick
USDA-ARS Soil Scientist (retired)
201 Johnson Hall, WSU
Pullman, WA 99164-6420
Tel:509-335-1553
Fax:509-335-8674
E-mail:papendic@mail.wsu.edu

Mr. Neil Fink
Deep-well irrigator and advisor
3790 Fink Road E
Odessa, WA 99159
Tel:509-982-2806
E-mail:NFink@Odessaoffice.com

D. Related Information
The applicant, William F. Schillinger, is a tenured faculty member with a research (85%) and extension (15%) appointment in the Department of Crop and Soil Sciences at Washington State University. Washington State University is the land grant research institution for the state of Washington. There is no conflict of interest.

COST PROPOSAL:

Line Item	6/1/02 to 6/1/03	Anticipated 6/1/03 to 6/1/04
Technical assistant (part time)[1]	12,100	12,500
Goods and Services[2]	5,200	5,400
Subtotal	17,300	17,900
WSU overhead @ 26%	4,500	
Total this request	**$21,800**	

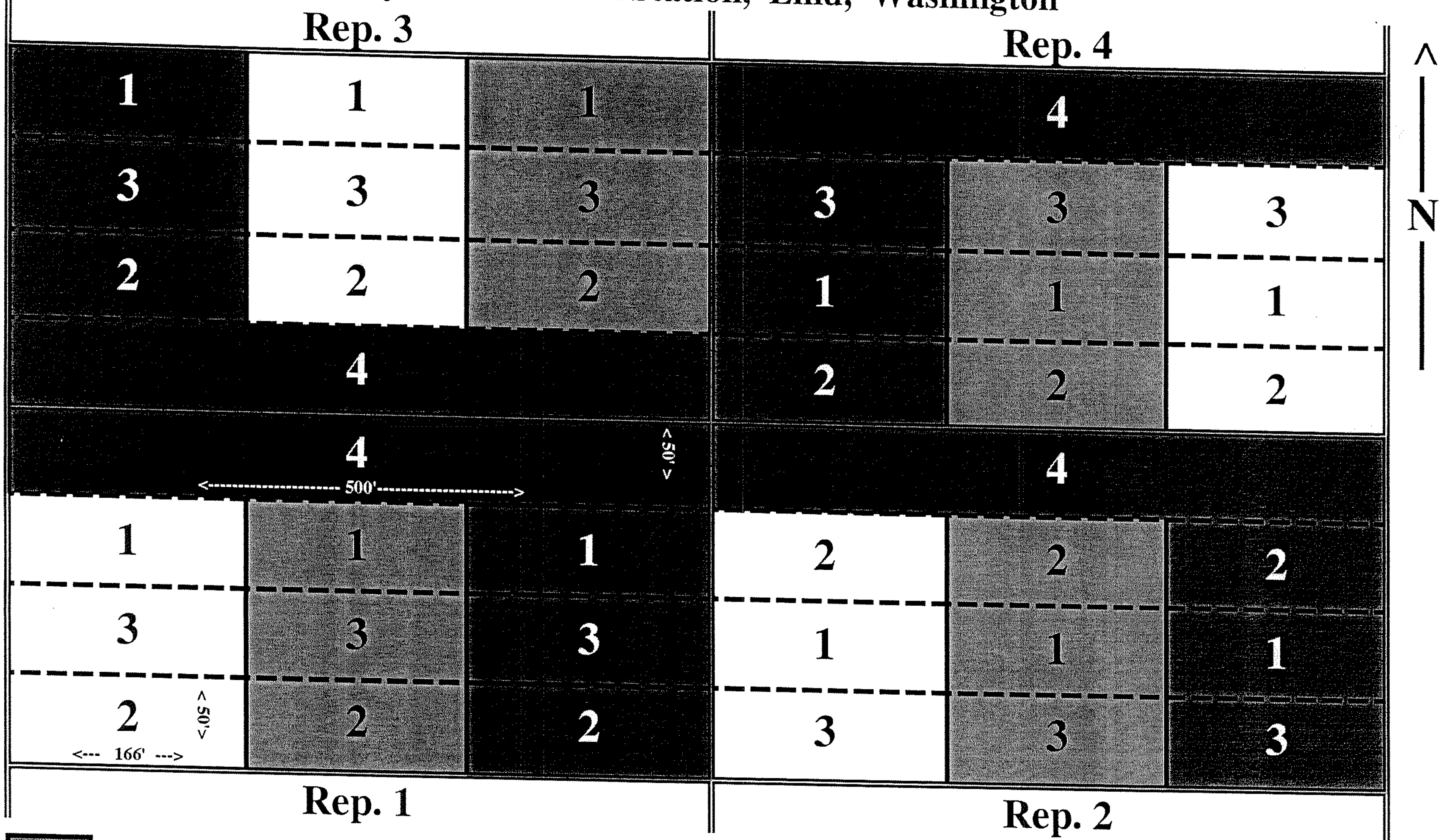
1 Wage of $17.25 per hour plus 36% benefits for Steve Schofstoll, WSU technical assistant.
2 Fertilizer, seed, herbicide, diesel, gasoline, lubricants, parts, electricity for deep-well irrigation.

Matching Funds: Washington State University provides salary and benefits for:
W.F. Schillinger (PI) at 15% time commitment = $15,980/year
H.L. Schafer (WSU research tech.) at 15% time commitment = $8,160/year
B.E. Sauer (WSU farm manager) at 10% time commitment = $5,830/year

Appendix 1:

Plot Layout For Irrigated Cropping Systems Study, 2001 Crop Year

Dryland Research Station, Lind, Washington



Residue Burned Mechanical Residue Removal Standing Residue

Plots Sizes: Treatments 1, 2, and 3 are 50' by 166' Treatment 4 is 50' by 500'

Treatment 1: Winter Canola

Treatment 2: Winter Wheat

Treatment 3: Spring Barely

Treatment 4: Contiunuous Burn, Plow, Winter Wheat

VITA - William F. Schillinger

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POSITION RESPONSIBILITIES: Provide leadership for cropping systems research and extension in low-rainfall (6-to 12-inch annual) dryland areas of eastern Washington. Research is focused on determining best management practices for reducing wind erosion, improving winter wheat stand establishment, decreasing water runoff from frozen soils, increasing cropping intensity, and developing technologies for no-till annual spring cropping which includes alternative crops. Serve as director of the WSU Dryland Research Station at Lind.

EDUCATION: Ph.D., Crop Science, Oregon State University, 1992; M.S., Agronomy, University of California at Davis, 1983; B.A., Communications, Eastern Washington University, 1974.

INVITED BOOK CHAPTERS:

Schillinger, W.F., R.I. Papendick, S.O. Guy, P.E. Rasmussen, and C. van Kessel. 2002. Dryland cropping in the western United States. *In* G.A. Peterson, P.W. Unger, and W.A. Payne (ed.) Dryland Cropping: A World View. American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America, Madison, WI (in press).

Kennedy, A.C., T.L. Stubbs, and W.F. Schillinger. 2002. Soil and crop management effects on soil biology. *In* Soil Organic Matter. Advances in Agroecology Series (accepted).

SCIENTIFIC JOURNAL PUBLICATIONS:

Stubbs, T.L., A.C. Kennedy, and W.F. Schillinger. 2002. Soil ecosystem changes during the transition to no-till cropping. *Journal of Crop Production* (in press).

Janosky, J.S., D.L. Young, and W.F. Schillinger. 2002. Economics of conservation tillage in a wheat-fallow rotation. *Agronomy Journal* (in press).

Schillinger, W.F. 2001. Minimum and delayed conservation tillage for wheat-fallow farming. *Soil Science Society of America Journal* 65:1203-1209.

Donaldson, E., W.F. Schillinger, and S.M. Dofing. 2001. Straw production and grain yield relationships in winter wheat. *Crop Science* 41:100-106.

Schillinger, W.F., and F.L. Young. 2000. Soil water use and growth of Russian thistle after wheat harvest. *Agronomy Journal* 92:167-172.

Schillinger, W.F., R.J. Cook, and R.I. Papendick. 1999. Increased dryland cropping intensity with no-till barley. *Agronomy Journal* 91:744-752.

Schillinger, W. F., R.I. Papendick, R.J. Veseth, and F.L. Young. 1999. Russian thistle skeletons provide residue during fallow. *Journal of Soil and Water Conservation* 54:506-509.

Schillinger, W.F., E. Donaldson, R.E. Allan, and S.S. Jones. 1998. Winter wheat seedling emergence from deep sowing depths. *Agronomy Journal* 90:582-586.

Schillinger, W.F., and R.I. Papendick. 1997. Tillage mulch depth effects during fallow on wheat production and wind erosion control factors. *Soil Science Society of America Journal* 61:871-876.

Schillinger, W.F., and D.E. Wilkins. 1997. Deep ripping fall-planted wheat after fallow to improve infiltration and reduce erosion. *Journal of Soil and Water Conservation* 52:198-202.

Schillinger, W.F. 1996. Packing summer fallow in the Pacific Northwest: Agronomic benefits and environmental concerns. *Agronomy Journal* 88:9-13.

Schillinger, W.F., and F.E. Bolton. 1996. Packing summer fallow in the Pacific Northwest: Seed zone water retention. *Journal of Soil and Water Conservation* 51:62-66.

Schillinger, W.F., and F.E. Bolton. 1993. Fallow water storage in tilled vs. untilled soils in the Pacific Northwest. *Journal of Production Agriculture* 6:267-269.

Cook, R.J., W.F. Schillinger, and N.W. Christensen. Rhizoctonia root rot and wheat take-all in diverse direct-seeded spring cropping systems. *Canadian Journal of Plant Pathology* (submitted).

PREVIOUS EXPERIENCE:

1993-1999: Assistant Scientist and Extension Specialist E-2, Department of Crop and Soil Sciences (1995-1999), Area Extension agronomy agent (1993-1995), Washington State University, Lind, Washington.

1989-1992: Graduate Research Assistant, Department of Crop and Soil Science, Oregon State University, Corvallis, Oregon.

1986-1989: Cropping Systems Research Agronomist, Winrock International/USAID, Kathmandu, Nepal.

1983-1986: Agriculture Project Manager (Foreign Service Officer), U.S. Agency for International Development, Cameroon, West Africa.

1975-1981: American Peace Corps, Kathmandu, Nepal. Agricultural Program Director (1979-1981); Seed Specialist (PCV) (1975-1978).

Other: Grew up on family's dryland wheat farm in Adams County, Washington.

AFFILIATIONS:

American Society of Agronomy
Soil Science Society of America
Washington Association of Wheat Growers
Soil and Water Conservation Society
Gamma Sigma Delta Honor Society of Agriculture

EXHIBIT A

CERTIFICATIONS AND ASSURANCES

I/we make the following certifications and assurances as a required element of the proposal to which it is attached, understanding that the truthfulness of the facts affirmed here and the continuing compliance with these requirements are conditions precedent to the award or continuation of the related contract(s):

1. I/we declare that all answers and statements made in the proposal are true and correct.

2. The prices and/or cost data have been determined independently, without consultation, communication, or agreement with others for the purpose of restricting competition. However, I/we may freely join with other persons or organizations for the purpose of presenting a single proposal.

3. The attached proposal is a firm offer for a period of 60 days following receipt, and it may be accepted by the AGENCY without further negotiation (except where obviously required by lack of certainty in key terms) at any time within the 60-day period.

4. In preparing this proposal, I/we have not been assisted by any current or former employee of the state of Washington whose duties relate (or did relate) to this proposal or prospective contract, and who was assisting in other than his or her official, public capacity. (Any exceptions to these assurances are described in full detail on a separate page and attached to this document.)

5. I/we understand that the AGENCY will not reimburse me/us for any costs incurred in the preparation of this proposal. All proposals become the property of the AGENCY, and I/we claim no proprietary right to the ideas, writings, items, or samples, unless so stated in this proposal.

6. Unless otherwise required by law, the prices and/or cost data which have been submitted have not been knowingly disclosed by the Proposer and will not knowingly be disclosed by him/her prior to opening, directly or indirectly to any other Proposer or to any competitor.

7. I/we agree that submission of the attached proposal constitutes acceptance of the solicitation contents and the attached sample contract and general terms and conditions. If there are any exceptions to these terms, I/we have described those exceptions in detail on a page attached to this document.

8. No attempt has been made or will be made by the Proposer to induce any other person or firm to submit or not to submit a proposal for the purpose of restricting competition.

William F. Schillinger

Signature of Proposer

WSU Research Agronomist 4-18-02

Title Date